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(54) Title of the Invention

Image Display Apparatus and
Manufacturing Method Thereof

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SPECIFICATION

1. Title of the Invention

Image Display Apparatus and
Manufacturing Method Thereof

2. Scope of Claim for Patent

(1) An image display apparatus characterized in that two different kinds of insulating layers through which a hole is formed exist between polysilicon deposited on a quartz substrate and a pixel electrode layer, said polysilicon is directly in contact with said pixel electrode layer in the region of said hole, and said hole is sharply enlarged so as to be widen upward.

(2) A method of manufacturing an image display apparatus, characterized by including a step of depositing a pixel electrode layer in such a manner that when two insulating layers deposited on polysilicon on a quartz substrate are etched to form a hole reaching said polysilicon, the side wall of the hole is made to slant by utilizing side-etching of an upper insulating layer, and the pixel electrode layer is deposited thereon.

3. Detailed Description of the Invention

[Industrial Field of Application]

The present invention relates to an image display apparatus capable of being used as a display for a word processors, a television, or various computers, and to a manufacturing method thereof.

[Prior Art]

Explanation will now be made with respect to the structure of conventional contact between a pixel electrode layer and polysilicon to form a thin film transistor for switching. Fig. 3 shows the structure of a conventional contact portion. In Fig. 3, reference numeral 11 denotes a quartz substrate and reference numeral 12 indicates polysilicon. The thin film transistor for switching is formed by using the polysilicon 12. The polysilicon in the contact portion indicates an N-type or a P-type due to doping. Reference numeral 13 denotes NSG (Nondoped-

Silicon-Glass) for interlayer insulation; 14 p^l - $SiN_x(1)$ carrying out a function to protect Al wiring when ITO is etched; 15 Al; 16 Cr; 17 ITO as an pixel electrode; and 18 p^l - $SiN_x(2)$ as passivation.

[Problems that the Invention is to Solve]

In the above structure of the conventional contact portion, the ITO as a transparent pixel electrode is not directly in contact with the polysilicon but Al and Cr exist between them. Accordingly, there are such drawbacks that the number of processing steps necessary for the contact formation is increased, the yield in the manufacture of the image display apparatus is deteriorated, and it is comparatively high in cost.

It is an object of the invention to provide an image display apparatus in which the conventional drawbacks are solved, the structure is simplified, and the number of manufacturing processes is small.

[Means for Solving the Problems]

According to the invention, there is provided an image display apparatus wherein two different kinds of insulating layers through which a hole is formed exist between polysilicon deposited on a quartz substrate and a pixel electrode layer, the polysilicon is directly in contact with the pixel electrode layer in the region of the hole, and the hole is sharply enlarged so as to be widen

upward.

There is provided a manufacturing method thereof including a step of depositing a pixel electrode layer in such a manner that when two insulating layers deposited on polysilicon on a quartz substrate are etched to form a hole reaching the polysilicon, the side wall of the hole is made to slant by utilizing side-etching of the upper insulating layer and the pixel electrode layer is deposited thereon.

[Operation]

Due to the structure and method of forming a contact hole according to the invention, a process to form a Cr layer can be eliminated, the process can be simplified as compared with the conventional one, and the contact between the polysilicon and ITO can be surely formed. Consequently, it is possible to improve the manufacturing yield of the apparatus can be raised and, further, the cost can be reduced.

[Embodiment]

An embodiment according to the invention will now be described with reference to Figs. 1 and 2A and 2B.

Fig. 1 is a constructional diagram of a contact portion between a pixel electrode layer and a thin film transistor forming layer according to the invention. In Fig. 1, reference numeral 1 denotes a quartz substrate and reference numeral 2 indicates polysilicon. A thin film

transistor for switching is formed by using the polysilicon 2. The polysilicon in the contact portion is set to N-type or P-type due to doping. Reference numeral 3 denotes NSG for interlayer insulation; 4 $\text{p}^{\ell}\text{-SiN}_x(1)$; 5 ITO of the pixel electrode; and 6 $\text{p}^{\ell}\text{-SiN}_x(2)$ as passivation. As mentioned above, the polysilicon 2 is directly in contact with the ITO 5.

Subsequently, a method of forming the contact will now be described on the basis of Fig. 2. As shown in Fig. 2A, the polysilicon 2, NSG 3, $\text{p}^{\ell}\text{-SiN}_x$ 4 are sequentially deposited on the quartz substrate 1. A portion where the contact is formed is patterned by a resist 7. Subsequently, the resultant one is etched by using a hydrofluoric acid solution of 7%. The etching rate of the $\text{p}^{\ell}\text{-SiN}_x$ to the 7% hydrofluoric acid solution is quicker than that of the NSG. Accordingly, when the etching is performed, the $\text{p}^{\ell}\text{-SiN}_x$ is considerably side-etched. Consequently, when the contact hole reaches the polysilicon 2, it is as shown in Fig. 2B. That is, the contact hole is not formed in a step form but the side wall of the contact hole becomes gently-sloping. After the contact hole is formed as mentioned above, the resist 7 is removed, the ITO is deposited, and a heat treatment is performed at 125°C for 30 minutes to form ohmic contact directly between the ITO and the polysilicon. Finally, the $\text{p}^{\ell}\text{-SiN}_x$ as passivation is deposited, so that

the structure of the contact portion shown in Fig. 1 is completed.

When the image display apparatus is formed by using the structure of the invention, the apparatus offers the same characteristics as the conventional one.

In the embodiment, the 7% hydrofluoric acid solution is used as an etching liquid to form the contact hole. The etching liquid to allow the etching rate of the p^{ℓ} - SiN_x to be quicker than that of the NSG may be used.

As mentioned above, according to the embodiment, even when the ITO is directly in contact with the polysilicon, the same image characteristics as the conventional one can be obtained. Consequently, the yield is raised as much as a decrease in number of manufacturing processes, so that the cost can be reduced.

[Effects of the Invention]

According to the invention, the formation of the contact hole is devised to allow the ITO to be directly in contact with the polysilicon, so that the manufacturing process can be simplified, the yield is raised, and the cost is drastically reduced. The effects on the practical use are large.

4. Brief Description of the Drawings

Fig. 1 is a constructional diagram of a contact portion between ITO and polysilicon of an image display

apparatus in an embodiment of the invention; Figs. 2A and 2B are process diagrams showing a method of manufacturing the contact portion; and Fig. 3 is a constructional diagram of a contact portion of a conventional image display apparatus.

1... quartz substrate, 2... polysilicon, 3... NSG, 4... p^l-SiN_x(1), 5... ITO, 6... p^l-SiN_x(2)

Applicant: Matsushita Electronics Corp.

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[Distinction of Official Gazette]

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Amendment (voluntary)

March 22, 1993

To Commissioner,

1. Case Number: Japanese Patent No. 1-98721/1989

2. Title of the Invention

Image Display Apparatus and Manufacturing Method
Thereof

3. Person who makes the Amendment

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5. Number of Claims increased by Amendment 0

6. Object of Amendment

Columns of "Scope of Claim for Patent", "Detailed Description of the Invention", and "Detailed Description of the Drawings" of the specification

7. Contents of the Amendment

(1) "Scope of Claim for Patent" is amended as per annexed paper

(2) At lines 7 to 8, page 2 of the specification (at line 17, page 33 of the translated specification), "of contact" is amended to "of a contact portion".

(3) At line 14, page 2 of the specification (at line 1, page 34), "Silicon" is amended to "Silicate".

(4) At line 15, page 2 of the specification (at lines 1 to 2, page 34), "for interlayer insulation" is amended to "as an interlayer insulating film".

- (5) At lines 15 to 16, page 2 of the specification (at line 3, page 34), "when ITO is etched" is amended to "when ITO 17 is etched".
- (6) At line 1, page 3 of the specification (at lines 8 to 9, page 34), "the ITO ... the polysilicon" is amended to "the ITO 17 ... the polysilicon 12".
- (7) At line 2, page 3 of the specification (at line 9, page 34), "Al and Cr" is amended to "the Al 15 and the Cr 16".
- (8) At lines 11, 12, 14, 16, and 19, page 3 of the specification (at line 22 in page 34, at line 1 in page 35), "hole" is amended to "contact window".
- (9) At lines 16 to 18, page 3 of the specification (at lines 4 to 7, page 35), "(including a step of depositing a pixel electrode layer in such a manner that when) two insulating layers deposited on polysilicon on a quartz substrate are etched (to form a hole reaching the polysilicon)" is amended to "(including) a step of forming two insulating layers on polysilicon, in which the upper layer has an etching rate higher than that of the lower layer, on polysilicon(, when a hole reaching the polysilicon is formed) by etching,".
- (10) At line 20, page 3 of the specification (at lines 7 to 10, page 35), "the side wall (of the hole) is made to slant (by utilizing side-etching of the upper insulating

layer and the pixel electrode layer is deposited) thereon" is amended to "a step of making the side wall (of the contact window) slant (by utilizing side-etching of the upper insulating layer,) and (a step of depositing a pixel electrode layer) on the surface".

(11) At lines 3 to 5, page 4 of the specification (at lines 12 to 14, page 35), "Due to of the invention, can be eliminated" is amended as follows.

"Due to the structure and method of forming the contact window of the invention, the process of forming the Al layer and the Cr layer can be eliminated and the polysilicon and pixel electrode layer can be deposited without interruption. Therefore,"

(12) At lines 6 to 7, page 4 of the specification (at lines 16 to 17, page 35), "can be surely formed" is amended to "can be surely performed".

(13) At line 7, page 4 of the specification (at line 18, page 35), "of the apparatus" is amended to "of the image display apparatus".

(14) At lines 7 to 8, page 4 of the specification (at line 18, page 35), "can be raised" is amended to "can be improved".

(15) At line 17, page 4 of the specification (at line 3, page 36), "is formed" is amended to "has been formed".

(16) At lines 19 to 20, page 4 of the specification (at

lines 5 to 6, page 36), "Reference numeral 3 denotes NSG for interlayer insulation; 4 $p\ell$ - $\text{SiN}_x(1)$ " is amended to "Reference numeral 3 denotes NSG used as a lower interlayer insulating film; 4 $p\ell$ - $\text{SiN}_x(1)$ used as an upper interlayer insulating film".

(17) At lines 2 to 3, page 5 of the specification (at line 8, page 36), "As mentioned above, the polysilicon 2 is directly in contact with the ITO 5" is amended to "The polysilicon 2 is directly in contact with the ITO 5 through a contact window formed through the NSG 3 and $p\ell$ - $\text{SiN}_x(1)$ 4. The contact window has such a structure that it is extended upward."

(18) At lines 4 and 7 to 8, page 5 of the specification (at lines 10 and 14, page 36), "contact" is amended to "contact window".

(19) At lines 6 to 7, 11, and 12, page 5 of the specification (at lines 12, 17, and 19, page 36), " $p\ell$ - SiN_x " is amended to " $p\ell$ - $\text{SiN}_x(1)$ 4".

(20) At line 10, page 5 of the specification (at line 18, page 36), "NSG" is amended to "NSG 3".

(21) At line 11 in page 5 and line 9 in page 6 of the specification (at line 17 in page 36 and line 12 in page 37), "quicker" is amended to "higher".

(22) At lines 13, 15, 16, and 17, page 5 of the specification (at lines 20, 22, 23, and 24, page 36),

"contact hole" is amended to "contact window".

(23) At lines 18 and 20, page 5 of the specification (at line 25 in page 36 and line 2 in page 37), "ITO" is amended to "ITO 5".

(24) At line 20, page 5 of the specification (at line 2, page 37), "polysilicon" is amended to "polysilicon 2".

(25) At line 20 in page 5 to line 1 in page 6 of the specification (at lines 1 to 2, page 37), "form ohmic contact directly" is amended to "obtain ohmic contact directly".

(26) At line 2, page 6 of the specification (at line 3, page 37), " $p\ell$ -SiN_x" is amended to " $p\ell$ -SiN_x(2) 6".

(27) At lines 6 and 16, page 6 of the specification (at lines 10 to 11 and 21, page 37), "contact hole" is amended to "contact window".

(28) At line 9, page 6 of the specification (at lines 11 to 12, page 37), "The (etching liquid ...) may be used" is amended to "Any (etching liquid ...) can be used".

(29) At line 4, page 7 of the specification (at line 6, page 38), "contact portion" is amended to "contact window".

Document describing the Scope of Claim for Patent

Scope of Claim for Patent

(1) An image display apparatus characterized in that two different kinds of layers through which a contact window is formed exist between polysilicon deposited on a quartz substrate and a pixel electrode layer, said polysilicon is directly in contact with said pixel electrode layer in the region of said contact window, and the contact window is sharply enlarged to as to be extended upward.

(2) A method of manufacturing an image display apparatus, characterized by including: a step of forming two insulating layers in which the etching rate of an upper layer is higher than that of a lower layer on polysilicon on a quartz substrate; a step of forming a contact window reaching said polysilicon due to etching and making the side wall of the contact window slant by utilizing side-etching of the insulating layer as said upper layer; and a step of depositing a pixel electrode layer on the surface.

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008498570 **Image available**

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**Image display unit - has two insulation layers and polycrystalline
silicon directly connected to picture element electrode layer NoAbstract**

Dwg 1/3

Patent Assignee: MATSUSHITA ELECTRONICS CORP (MATE)

Number of Countries: 001 Number of Patents: 001

Patent Family:

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Priority Applications (No Type Date): JP 8998721 A 19890420

Title Terms: IMAGE; DISPLAY; UNIT; TWO; INSULATE; LAYER; POLY; CRYSTAL;
SILICON; CONNECT; PICTURE; ELEMENT; ELECTRODE; LAYER; NOABSTRACT

Derwent Class: L03; P81; P85; U11; U14

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⑮発明の名称 画像表示装置およびその製造方法

⑯特 願 平1-98721

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明 細 書

1. 発明の名称

画像表示装置およびその製造方法

2. 特許請求の範囲

(1) 石英基板上に堆積された多結晶シリコンと画素電極層との間には穴のあいている種類の異なる二層の絶縁層があり、前記穴の領域で多結晶シリコンと画素電極層とは直接接触しており、前記穴は上層に行くにしたがって急激に大きくなっていることを特徴とする画像表示装置。

(2) 石英基板上の多結晶シリコン上に堆積した二層の絶縁層にエッチングによって多結晶シリコンに達する穴を形成するとき、上層の絶縁層のサイドエッチングを利用して穴の側壁がなだらかな傾斜状となり、その上に画素電極層を堆積する工程を含むことを特徴とする画像表示装置の製造方法。

3. 発明の詳細な説明

(産業上の利用分野)

本発明は、ワープロ、テレビジョン、各種コンピュータのディスプレイとして用いることができる画像表示装置およびその製造方法に関するものである。

(従来の技術)

従来の画素電極層とスイッチング用の薄膜トランジスタを形成する多結晶シリコンとのコンタクトの構造を説明する。第3図に従来のコンタクト部の構造を示す。同図において、11は石英基板、12は多結晶シリコンである。スイッチング用の薄膜トランジスタは、多結晶シリコン12を用いて形成される。また、コンタクト部の多結晶シリコンは、ドーピングによりN型あるいはP型になっている。13はNSG(Nondoped-Silicon-Glass)で、層間絶縁用である。14は $p^+ - SiN_x(1)$ で、ITOエッチングのときにA₂配線を保護する役割をする。15はA₂、16はCr、17は画素電極のITOであり、18はパッシベーションの $p^+ - SiN_x(2)$ である。

(発明が解決しようとする課題)

上記従来のコンタクト部の構造では、透明画素

電極のITOと多結晶シリコンは直接コンタクトしておらず、間にAlとCrが介在しており、コンタクト形成に必要な工程数が多くなり、画像表示装置の製造において歩留りを低下させ、原価も割高になる欠点があった。

本発明の目的は、従来の欠点を解消し、簡易な構造で、しかも製造工程数も少なくすむ画像表示装置を提供することである。

(課題を解決するための手段)

本発明の画像表示装置は、石英基板上に堆積された多結晶シリコンと画素電極層との間には穴のあいている電気の異なる二層の絶縁層があり、穴の領域で多結晶シリコンと画素電極層とは直接接触しており、穴は上層に行くにしたがって急激に大きくなっているものである。

またその製造方法は、石英基板上の多結晶シリコン上に堆積した二層の絶縁層にエッチングによって多結晶シリコンに通する穴を形成するとき、上層の絶縁層のサイドエッチングを利用して穴の側壁がなだらかな傾斜状となり、その上に画素電

極のITOであり、6はパッシベーションの $p\text{-SiN}_x$ (2)である。以上のように、多結晶シリコン2とITO5は直接コンタクトしている。

次に、コンタクトの製造方法を第2図に基づいて説明する。まず、第2図(a)に示すように、石英基板1上に多結晶シリコン2、NSG3、 $p\text{-SiN}_x$ 4を順に堆積し、レジスト7によりコンタクトを形成する部分をパターンニングする。次に、7%弗酸水溶液を用いてエッチングを行う。7%弗酸水溶液に対するエッチングレートは、NSGに比べ $p\text{-SiN}_x$ は速い。そのため、エッチングを行うと $p\text{-SiN}_x$ はかなりサイドエッチングされる。その結果、コンタクトの穴が多結晶シリコン2に通したときには、第2図(b)に示すようになる。すなわち、コンタクトの穴はステップ状に形成されるのではなく、コンタクトの穴の側壁はなだらかな傾斜状になる。このように、コンタクトの穴を形成したあと、レジスト7を除去し、ITOを堆積し、125℃で30分間熱処理を施すことにより、ITOと多結晶シリコンとの間に直接オーミック

極層を堆積する工程を含むものである。

(作用)

本発明の構造およびコンタクト穴の形成方法により、Cr層を形成するプロセスをなくすることができ、従来に比べプロセス工程を簡単化でき、多結晶シリコンとITOのコンタクトを確実に形成でき、その結果として、装置の製造歩留りを向上することができ、さらに原価を低減することができる。

(実施例)

本発明の一実施例を第1図および第2図に基づいて説明する。

第1図は、本発明の画素電極層と薄膜トランジスタ形成層のコンタクト部の構造図である。同図において、1は石英基板、2は多結晶シリコンである。スイッチング用の薄膜トランジスタは、多結晶シリコン2を用いて形成される。また、コンタクト部の多結晶シリコンは、ドーピングによりN型あるいはP型になっている。3はNSGで、層間絶縁層である。4は $p\text{-SiN}_x$ (1)、5は画素電

コンタクトを形成し、最後にパッシベーションの $p\text{-SiN}_x$ を堆積し、第1図に示したコンタクト部の構造を完成させる。

本発明の構造を用いて画像表示装置を作製したところ、従来と変わらない特性を示した。

なお、本実施例では、コンタクト穴を形成するエッチング液として7%弗酸水溶液を用いたが、NSGよりも $p\text{-SiN}_x$ の方がエッチングレートの速いエッチング液ならばよい。

以上のように、本実施例によれば、ITOと多結晶シリコンとを直接コンタクトしても、従来と同じ特性の画像特性が得られることから、製造工程の減った分だけ歩留りが上がり、原価を低減することができる。

(発明の効果)

本発明によれば、コンタクト穴の形成を工夫することにより、ITOと多結晶シリコンを直接コンタクトすることにより、製造工程を簡単化でき、歩留りも高くなり、原価を大幅に低減することができ、その実用上の効果は大である。

第 1 図

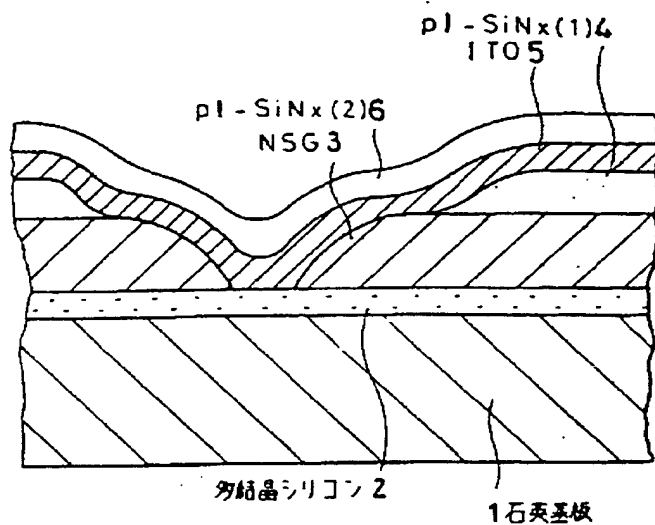
4. 図面の簡単な説明

第1図は本発明の一実施例における画像表示装置のITOと多結晶シリコンのコンタクト部の構成図、第2図は同コンタクト部の製造方法を示す工程図、第3図は従来の画像表示装置のコンタクト部の構成図である。

1…石英基板、 2…多結晶シリコン、
3…NSG、 4… $\text{pl-SiNx}(1)$ 、 5…ITO、
6… $\text{pl-SiNx}(2)$ 。

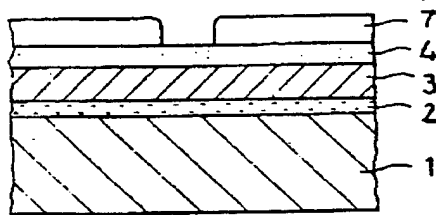
特許出願人 松下電子工業株式会社

代理人 星野恒司

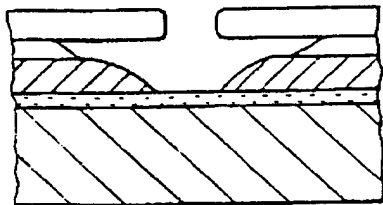


第 2 図

(a)



(b)



第 3 図

